

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

- 1 1. (Withdrawn) A method for forming a differential GMR sensor,
2 comprising:
3 forming a first shield and first gap layer;
4 forming a first self-pinned GMR sensor having a first pinned layer, a first spacer
5 layer and a first free layer;
6 forming a bias structure over the first free layer, wherein the bias structure is
7 formed to provide antiparallel magnetizations for the first and second free layers without
8 using an antiferromagnetic layer; and
9 forming a second self-pinned GMR sensor having a second pinned layer, a second
10 spacer layer and a second free layer.
- 1 2. (Withdrawn) The method of claim 1, wherein the forming the bias
2 structure further comprises forming four ferromagnetic layers separated with three
3 interlayers selected to provide a desired gap length.
- 1 3. (Withdrawn) The method of claim 1, wherein the forming the bias
2 structure further comprises forming four ferromagnetic layers separated with three
3 interlayers.
- 1 4. (Withdrawn) The method of claim 3, wherein the forming four
2 ferromagnetic layers further comprises forming four NiFe layers.

1 5. (Withdrawn) The method of claim 4, wherein the forming four NiFe
2 layers further comprises forming four NiFe layers having a nickel composition of 90%.

1 6. (Withdrawn) The method of claim 3, wherein the forming four
2 ferromagnetic layers separated with three interlayers further comprises forming three
3 interlayer comprises ruthenium.

1 7. (Withdrawn) The method of claim 1, wherein the forming the bias
2 structure further comprises forming the bias structure with a layer of tantalum, a layer of
3 aluminum oxide, a layer of nickel-iron-chromium and a layer of oxine copper.

1 8. (Withdrawn) The method of claim 7, wherein the forming the layer of
2 aluminum oxide further comprises a layer of aluminum oxide having a thickness selected
3 to minimize current shunting.

1 9. (Withdrawn) The method of claim 1, wherein the forming a first self-
2 pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer
3 and forming a second self-pinned GMR sensor having a second pinned layer, a second
4 spacer layer and a second free layer further comprises forming the first and second free
5 layer using a first free sublayer, an interlayer and a second free sublayer.

1 10. (Withdrawn) The method of claim 9, wherein the forming the first and
2 second free layer further comprises biasing the first and second free layer 180° out of
3 phase.

1 11. (Withdrawn) The method of claim 10, wherein the biasing the first and
2 second free layer 180° out of phase further comprises using in-phase pinned layers.

1 12. (Withdrawn) The method of claim 1, wherein the forming a first self-
2 pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer
3 and forming a second self-pinned GMR sensor having a second pinned layer, a second
4 spacer layer and a second free layer further comprises forming self-pinned pinned layers.

1 13. (Withdrawn) The method of claim 1, wherein the forming a first self-
2 pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer
3 and forming a second self-pinned GMR sensor having a second pinned layer, a second
4 spacer layer and a second free layer further comprises forming the first and second
5 pinned layers with antiparallel magnetizations to provide a net magnetostatic bias of zero
6 for the first and for the second pinned layers.

1 14. (Withdrawn) The method of claim 1, wherein the forming a first self-
2 pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer
3 and forming a second self-pinned GMR sensor having a second pinned layer, a second
4 spacer layer and a second free layer further comprises forming the first pinned layer using
5 three ferromagnetic layers..

1 15. (Withdrawn) The method of claim 1, wherein the forming a first self-
2 pinned GMR sensor having a first pinned layer, a first spacer layer and a first free layer
3 and forming a second self-pinned GMR sensor having a second pinned layer, a second
4 spacer layer and a second free layer further comprises forming a bottom pinned layer
5 using a first top ferromagnetic layer, a first spacer and a first bottom ferromagnetic layer
6 and forming a top pinned layer using a second top ferromagnetic layer, a second spacer
7 and a second bottom magnetic layer.

1 16. (Withdrawn) The method of claim 15, wherein the forming the first
2 bottom ferromagnetic layer and the second top ferromagnetic layer are formed using a
3 high field reset.

1 17. (Withdrawn) The method of claim 15, wherein the forming the first top
2 ferromagnetic layer and the second bottom ferromagnetic layer are formed having a
3 magnetization 180° out of phase.

1 18. (Currently Amended) A differential GMR sensor, comprising:
2 a first self-pinned GMR sensor having a first pinned layer, a first spacer layer and
3 a first free layer;
4 ~~a bias structure over the first free layer, wherein the bias structure is formed to~~
5 ~~provide antiparallel magnetizations for the first and second free layers without using an~~
6 ~~antiferromagnetic layer; and~~
7 a second self-pinned GMR sensor having a second pinned layer, a second spacer
8 layer and a second free layer; and
9 a bias structure disposed between the first free layer of the first self-pinned GMR
10 sensor and the second free layer of the second self-pinned GMR sensor, wherein the bias
11 structure is configured to provide antiparallel magnetizations for the first and second free
12 layers without using an antiferromagnetic layer.

1 19. (Currently Amended) The sensor of claim 18, wherein the bias structure
2 further comprises four ferromagnetic layers separated with three interlayers selected to
3 provide a desired gap length.

1 20. (Original) The sensor of claim 18, wherein the bias structure further
2 comprises four ferromagnetic layers separated with three interlayers.

1 21. (Currently Amended) The sensor of claim 20, wherein the four
2 ferromagnetic layers further ~~[[comprises]]~~ comprise four NiFe layers.

1 22. (Currently Amended) The sensor of claim 21, wherein the four NiFe [[
2 comprises]] comprise a nickel composition of 90%.

1 23. (Currently Amended) The sensor of claim 20, wherein the three
2 interlayers further [[comprises]] comprise ruthenium.

1 24. (Withdrawn) The sensor of claim 18, wherein the bias structure further
2 comprises a layer of tantalum, a layer of aluminum oxide, a layer of nickel-iron-
3 chromium and a layer of oxine copper.

1 25. (Withdrawn) The sensor of claim 24, wherein the layer of aluminum
2 oxide further comprises a thickness selected to minimize current shunting.

1 26. (Withdrawn) The sensor of claim 18, wherein the first and second free
2 layer each further comprises a first free sublayer, an interlayer and a second free sublayer.

1 27. (Withdrawn) The sensor of claim 26, wherein the first and second free
2 layer are biased 180° out of phase.

1 28. (Withdrawn) The sensor of claim 27, wherein the first and second free
2 layer are biased 180° out of phase using in-phase pinned layers.

1 29. (Withdrawn) The sensor of claim 18, wherein the first pinned layer and
2 second pinned layer further comprises self-pinned pinned layers.

1 30. (Withdrawn) The sensor of claim 18, wherein the first and second pinned
2 layers further comprises antiparallel magnetizations for providing a net magnetostatic
3 bias of zero for the first and for the second pinned layers.

1 31. (Withdrawn) The sensor of claim 18, wherein the first pinned layer
2 further comprises three ferromagnetic layers.

1 32. (Withdrawn) The sensor of claim 18, wherein the first pinned layer
2 comprises a bottom pinned layer having a first top ferromagnetic layer, a first spacer and
3 a first bottom ferromagnetic layer and the second pinned layer comprises a top pinned
4 layer having a second top ferromagnetic layer, a second spacer and a second bottom
5 magnetic layer.

1 33. (Withdrawn) The sensor of claim 32, wherein the first top ferromagnetic
2 layer and the second bottom ferromagnetic layer have a magnetization 180° out of phase.

1 34. (Currently Amended) A magnetic disk recording system, comprising:
2 a magnetic storage medium having a plurality of tracks for recording of data; and
3 a magnetic transducer maintained in a closely spaced position relative to the
4 magnetic storage medium during relative motion between the magnetic transducer and
5 the magnetic storage medium, the magnetic transducer including a magnetoresistive read
6 sensor, the magnetoresistive read sensor further comprising:

7 a first self-pinned GMR sensor having a first pinned layer, a first spacer
8 layer and a first free layer;

9 ~~a bias structure over the first free layer, wherein the bias structure is~~
10 ~~formed to provide antiparallel magnetizations for the first and second free layers without~~
11 ~~using an antiferromagnetic layer; and~~

12 a second self-pinned GMR sensor having a second pinned layer, a second
13 spacer layer and a second free layer; and

14 a bias structure disposed between the first free layer of the first self-pinned
15 GMR sensor and the second free layer of the second self-pinned GMR sensor, wherein
16 the bias structure is configured to provide antiparallel magnetizations for the first and
17 second free layers without using an antiferromagnetic layer.

1 35. (Currently Amended) The magnetic disk recording system of claim 34,
2 wherein the bias structure further comprises four ferromagnetic layers separated with
3 three interlayers selected to provide a desired gap length.

1 36. (Original) The magnetic disk recording system of claim 34, wherein
2 the bias structure further comprises four ferromagnetic layers separated with three
3 interlayers.

1 37. (Currently Amended) The magnetic disk recording system of claim 36,
2 wherein the four ferromagnetic layers further [[comprises]] comprise four NiFe layers.

1 38. (Currently Amended) The magnetic disk recording system of claim 37,
2 wherein the four NiFe [[comprises]] comprise a nickel composition of 90%.

1 39. (Currently Amended) The magnetic disk recording system of claim 36,
2 wherein the three interlayers further [[comprises]] comprise ruthenium.

1 40. (Withdrawn) The magnetic disk recording system of claim 34, wherein
2 the bias structure further comprises a layer of tantalum, a layer of aluminum oxide, a
3 layer of nickel-iron-chromium and a layer of oxine copper.

1 41. (Withdrawn) The magnetic disk recording system of claim 40, wherein
2 the layer of aluminum oxide further comprises a thickness selected to minimize current
3 shunting.

1 42. (Withdrawn) The magnetic disk recording system of claim 34, wherein
2 the first and second free layer each further comprises a first free sublayer, an interlayer
3 and a second free sublayer.

1 43. (Withdrawn) The magnetic disk recording system of claim 42, wherein
2 the first and second free layer are biased 180° out of phase.

1 44. (Withdrawn) The magnetic disk recording system of claim 43, wherein
2 the first and second free layer are biased 180° out of phase using in-phase pinned layers.

1 45. (Withdrawn) The magnetic disk recording system of claim 34, wherein
2 the first pinned layer and second pinned layer further comprises self-pinned pinned
3 layers.

1 46. (Withdrawn) The magnetic disk recording system of claim 34, wherein
2 the first and second pinned layers further comprises antiparallel magnetizations for
3 providing a net magnetostatic bias of zero for the first and for the second pinned layers.

1 47. (Withdrawn) The magnetic disk recording system of claim 34, wherein
2 the first pinned layer further comprises three ferromagnetic layers.

1 48. (Withdrawn) The magnetic disk recording system of claim 34, wherein
2 the first pinned layer comprises a bottom pinned layer having a first top ferromagnetic
3 layer, a first spacer and a first bottom ferromagnetic layer and the second pinned layer
4 comprises a top pinned layer having a second top ferromagnetic layer, a second spacer
5 and a second bottom magnetic layer.

1 49. (Withdrawn) The magnetic disk recording system of claim 48, wherein
2 the first top ferromagnetic layer and the second bottom ferromagnetic layer have a
3 magnetization 180° out of phase.

1 50. (Currently Amended) A differential GMR sensor, comprising:
2 first self-pinned means having a first pinned layer, a first spacer layer and a first
3 free layer;
4 a second self-pinned ~~GMR sensor~~ means having a second pinned layer, a second
5 spacer layer and a second free layer; and
6 means, disposed between the first free layer of the first self-pinned means and the
7 second free layer of the second self-pinned means, for biasing the first and second ~~pinned~~
8 free layers of the first and second self-pinned means to provide antiparallel
9 magnetizations for the first and second free layers without using an antiferromagnetic
10 layer.